## WE CLAIM:

- 1. A compliant apparatus comprising:
- a tubular structure formed from a tube made of a material having a reversible structural
- 3 behavior, and
- at least one compliant mechanism also formed from the tube as part of the tubular
- structure; wherein
- the compliant apparatus has no mechanical joints; and wherein
- the compliant apparatus is capable of being controlled to maneuver reversibly in
- various motions and degree-of-freedoms without permanent deformation.
- 1 2. The compliant apparatus of claim 1, wherein the cross-section of the tube is
- characterized as circular, oval, rectangular, square, straight, curvy, angular, or irregular.
- 1 3. The compliant apparatus of claim 1, wherein the reversible structural behavior is
- 2 characterized as elastic or superelastic.
- 1 4. The compliant apparatus of claim 1, wherein the material is selected from the group
- consisting of an elastic alloy including stainless steel and titanium alloy, and a superelastic
- alloy including nitinol, Cu-Al-Ni, Cu-Al, Cu-Zn-Al, Ti-V and Ti-Nb alloy.
- The compliant apparatus of claim 1, wherein the compliant mechanism stores strain
- energy and utilizes the stored energy as a bias force for shape recovery.
- 1 6. The compliant apparatus of claim 1, wherein the compliant mechanism is capable of
- being actuated by at least one actuators.

7. The compliant apparatus of claim 6, wherein the at least one actuators are made of

- 2 Shape Memory Alloys (SMAs) and wherein the SMAs are based on shape memory effects
- including contraction, rotation, and a combination thereof.
- 1 8. The compliant apparatus of claim 7, wherein the SMAs are configured for
- 2 manipulating the compliant apparatus and the compliant mechanism.
- 1 9. The compliant apparatus of claim 6, wherein the at least one actuators are
- 2 characterized as piezoelectric or electro-active polymer actuators.
- 1 10. The compliant apparatus of claim 6, wherein the at least one actuators are
- 2 characterized as wires connected to an external apparatus and actuated remotely via the
- 3 external apparatus.
- 1 11. The compliant apparatus of claim 6, wherein the at least one actuators are
- characterized as Shape Memory Alloy wires or Shape Memory Alloy springs.
- 1 12. A method of fabricating the compliant apparatus of claim 1, comprising:
- 2 forming the compliant mechanism and the tubular structure out of a tube with laser
- 3 machining.
- 1 13. The method of claim 12, wherein
- the laser machining having a laser beam size of about 50 μm or less.
- 14. The compliant apparatus of claim 1, further comprising at least one built-in micro
- structure selected from the group consisting of a welding-enabling structure and a clamping-
- 3 enabling structure.

1 15. A method of joining the compliant apparatus of claim 14 with at least one actuators, comprising the step of:

attaching the at least one actuators to the compliant apparatus via the at least one built-in micro structure.

- 1 16. The method of claim 15, wherein the at least one built-in micro structure is the
- welding-enabling structure, the method further comprising the step of:
- welding the at least one actuators to the welding-enabling structure using a laser.
- 5 17. The method of claim 16, wherein

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- the laser having a laser beam size of about 200 μm or less.
- 1 18. An ultrasonic imaging system useful for intravascular ultrasound forward imaging 2 applications, the ultrasonic imaging system comprising:
- a compliant apparatus having no mechanical joints and capable of being manipulated in various motions and degree-of-freedoms without permanent deformation, the compliant apparatus comprising:
- a tubular structure formed from a tube made of a material having a reversible structural behavior; and
- at least one compliant mechanism integrally formed from the tube;
- an ultrasound transducer coupled to the compliant apparatus; and
- at least one actuators attached to the compliant apparatus for manipulating the compliant apparatus and the at least one compliant mechanism.
- 1 19. The ultrasonic imaging system of claim 18, wherein the reversible structural behavior is characterized as elastic or superelastic.

1 20. The ultrasonic imaging system of claim 18, wherein the material is selected from the

- 2 group consisting of an elastic alloy including stainless steel and titanium alloy, and a
- superelastic alloy including nitinol, Cu-Al-Ni, Cu-Al, Cu-Zn-Al, Ti-V and Ti-Nb alloy.
- 1 21. The ultrasonic imaging system of claim 18, wherein the at least one actuators are made
- of Shape Memory Alloys (SMAs) and wherein the SMAs are based on shape memory
- effects including contraction, rotation, and a combination thereof to maximize output
- 4 displacement of the at least one compliant mechanism.
- The ultrasonic imaging system of claim 18, wherein the at least one actuators are
- 2 characterized as piezoelectric or electro-active polymer actuators.
- The ultrasonic imaging system of claim 18, wherein the at least one actuators are
- 2 characterized as wires connected to an external apparatus and actuated remotely via the
- 3 external apparatus.

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- 1 24. The ultrasonic imaging system of claim 18, further comprising:
- two additional actuators configured to actuate the compliant apparatus in an
- orthogonal direction, enabling the compliant apparatus to provide the ultrasound transducer
- 4 with full three dimensional scanning motions.
- 1 25. The ultrasonic imaging system of claim 24, wherein the at least one actuators and the
- two additional actuators are characterized as SMA wires or SMA springs.

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- 26. A micromanipulator useful for intravascular applications including imaging and
- therapy, the micromanipulator comprising:
- a tubular elastic or superelastic element having no mechanical joints and formed from a
- 4 tube made of a material having a reversible structural behavior; and

at least one actuators for manipulating the tubular elastic or superelastic element.

- The micromanipulator of claim 26, wherein the at least one actuators are selected from
- the group consisting of Shape Memory Alloy (SMA) actuators, piezoelectric actuators, and
- 3 electro-active polymer actuators.
- 1 28. The micromanipulator of claim 27, wherein the at least one actuators are characterized
- as wires connected to an external apparatus and actuated remotely via the external apparatus.

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- 1 29. A system useful for intravascular applications including imaging and therapy, the
- 2 system comprising:
- a micromanipulator having no mechanical joints and characterized as a tubular
- 4 structure made of an elastic or superelastic material; and
- a plurality of compliant mechanisms forming an integral part of the micromanipulator,
- 6 having various configurations, and positioned in various locations of the micromanipulator for
- 7 enabling intricate motions of the micromanipulator; and
- at least one actuators coupled to the plurality of compliant mechanisms for effecting
- 9 the intricate motions of the micromanipulator.
- 1 30. The system of claim 29, wherein the at least one actuators are selected from the group
- 2 consisting of Shape Memory Alloy (SMA) actuators, piezoelectric actuators, and electro-
- 3 active polymer actuators.
- The system of claim 29, wherein the at least one actuators are characterized as wires
- 2 connected to an external apparatus and actuated remotely via the external apparatus.

- 1 32. The system of claim 29, further comprising:
- two additional actuators configured to actuate the compliant apparatus in an
- orthogonal direction, enabling the micromanipulator with full three dimensional steering
- 4 motions.
- The system of claim 29, wherein the at least one actuators and the two additional
- actuators are characterized as SMA wires or SMA springs.
- 1 34. The system of claim 29, wherein
- each compliant mechanism is individually controllable via the at least one actuators.
- 1 35. The system of claim 29, wherein
- the at least one actuators are controlled by a remote electronic circuitry via a user
- 3 interface.
- 1 36. The system of claim 29, wherein
- the micromanipulator and the plurality of compliant mechanisms are assembled
- 3 together subsequent to being respectively formed.
- 1 37. The system of claim 29, further comprising:
- an ultrasound transducer coupled to the micromanipulator.
- 1 38. The system of claim 29, further comprising:
- a cooling system coupled to the micromanipulator for regulating temperature thereof.
- 1 39. The system of claim 38, wherein
- the cooling system comprises a pumping means and biocompatible cooling fluid; and
- 3 wherein

the pumping means provides a constant flow of the cooling fluid to the

5 micromanipulator to prevent the at least one actuators from overheating.